

APPLICATIONS for WDM TECHNOLOGY in MILITARY SYSTEMS

Presented at: DARPA/MTO WDM Workshop

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**Joseph Wilgus
Information Directorate
Wright-Patterson AFB OH
Air Force Research Laboratory**

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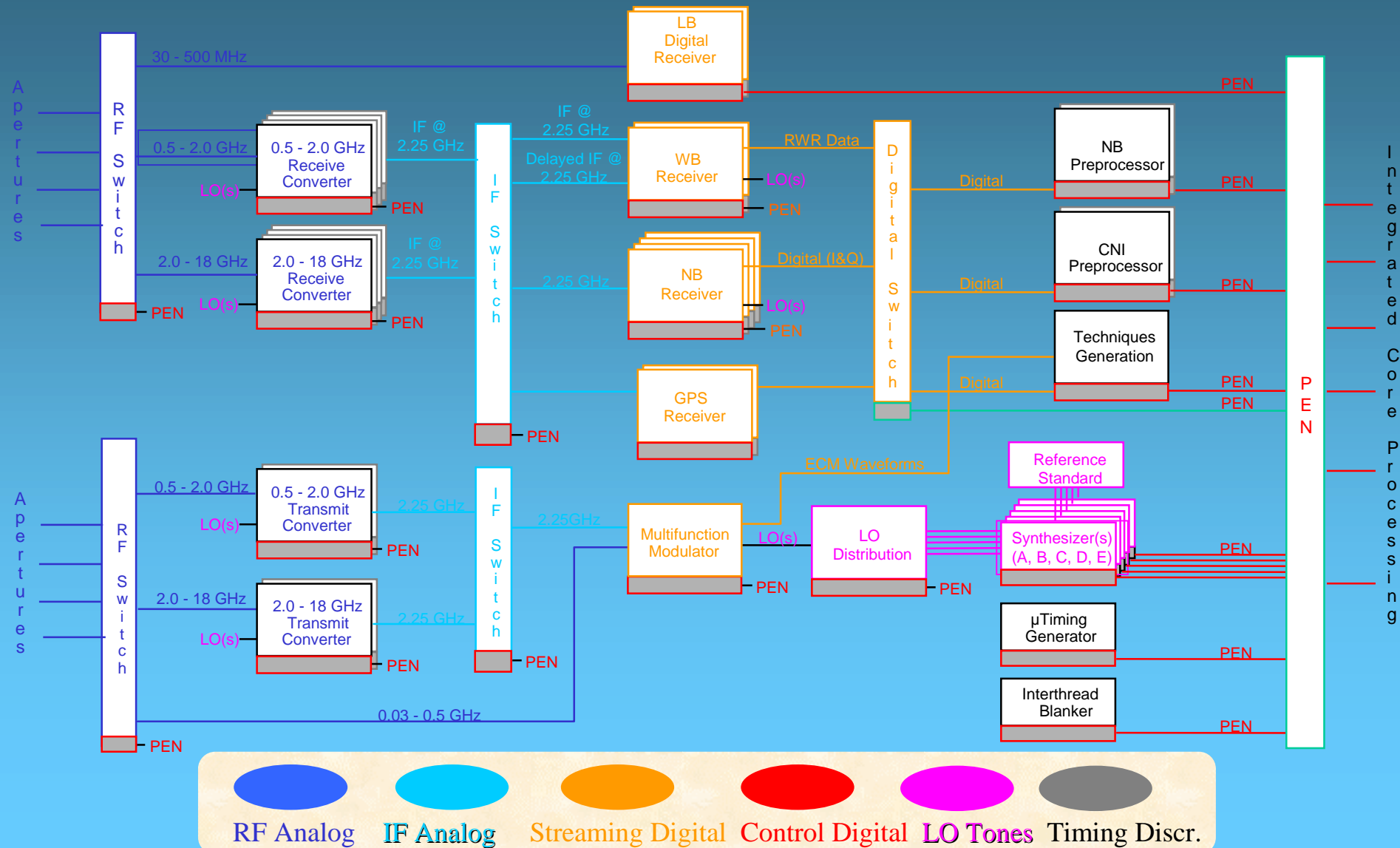


OUTLINE

- **Ways by which WDM has enhanced the effectiveness of military platforms**
- **System-Level Benefits**
- **Technical Challenges / Specific Platform Constraints**
- **Needed Developments**



ISS Network Requirements





Why WDM Is Needed For Avionics

Avionics Networks Characteristics

- Many Different I/O Types
 - RF, Analog, Digital, Discretes & Timing Strokes
 - EMI Problems in Mixed Signal Environment
- Many Different Network Media / Connectors
 - Coaxial, TSP, Copper Cable, F/O, Backplane Traces/Vias
- Many High Bandwidth/High Frequency Channels
- Avionics Modules are Connector Bound
 - Still Desire 2-Level Line-Replaceable Modules
- Sensors Located Throughout Airframe
 - Coaxial Cable Has High Signal Losses/Distortion
- Many Pt-to-Pt Cables Reduce Manufacturing Repeatability
 - Decrease Reliability/Effective Diagnostics

What is Needed is a Common Network That Can Satisfy All Connectivity Requirements of An Avionics Suite, Single Channel, Single Connector.

WDM Can Provide This Universal Avionics Network If Specific Component, Cost & Packaging Challenges Can Be Overcome!

The diagram illustrates a distributed antenna system architecture. At the top, four identical antenna units are shown, each consisting of a feed horn labeled 'Ku' and a multi-beam structure labeled 'V/P/L', 'S', and 'C'. Each antenna unit is connected to an 'AIU' (Antenna Interface Unit) block, which contains an 'FO Converter' (Frequency Offset Converter). The output of each AIU is connected to a common horizontal bus labeled 'Ant'. A red line labeled 'Cal' (Calibration) runs along the top, connecting the AIU blocks. Below the 'Ant' bus, a black line labeled 'Cal RF' (Calibration Radio Frequency) runs horizontally. A red line labeled 'Cal Distribution' connects the 'Cal' line to the 'Cal RF' line. A black line labeled 'Optical RF Distribution' connects the 'Ant' bus to the 'Cal RF' line. The 'Cal RF' line then branches out to three 'Remote RF Converter' blocks, each connected to a receiver labeled 'RCVR 1', 'RCVR 2', and 'RCVR 3' respectively. The 'Optical RF Distribution' line also branches out to the three 'Remote RF Converter' blocks. The BAE Systems logo is in the bottom right corner.



System-Level Benefits

- **Open to Technology Insertion**
- **Simplified Interconnect approach – can handle Any signal or combination of signals**
 - **Non-blocking sensor distribution (Each subsystem has access to any sensor at any time)**
- **Simplified RF Phase Matching**
 - **Accurate AOA**
- **Provides New design paradigm for embedded system architectures**
 - **Distance-Independent and Reconfigurable Designs**
- **Volume / Weight Savings**
- **Promotes use of COTs digital / RF Hardware**
- **Small, compact RF / Digital designs applicable to multiple platforms (UAVs, Fighters, Bombers, Helicopters, Cruisers, Ground Support, ...)**



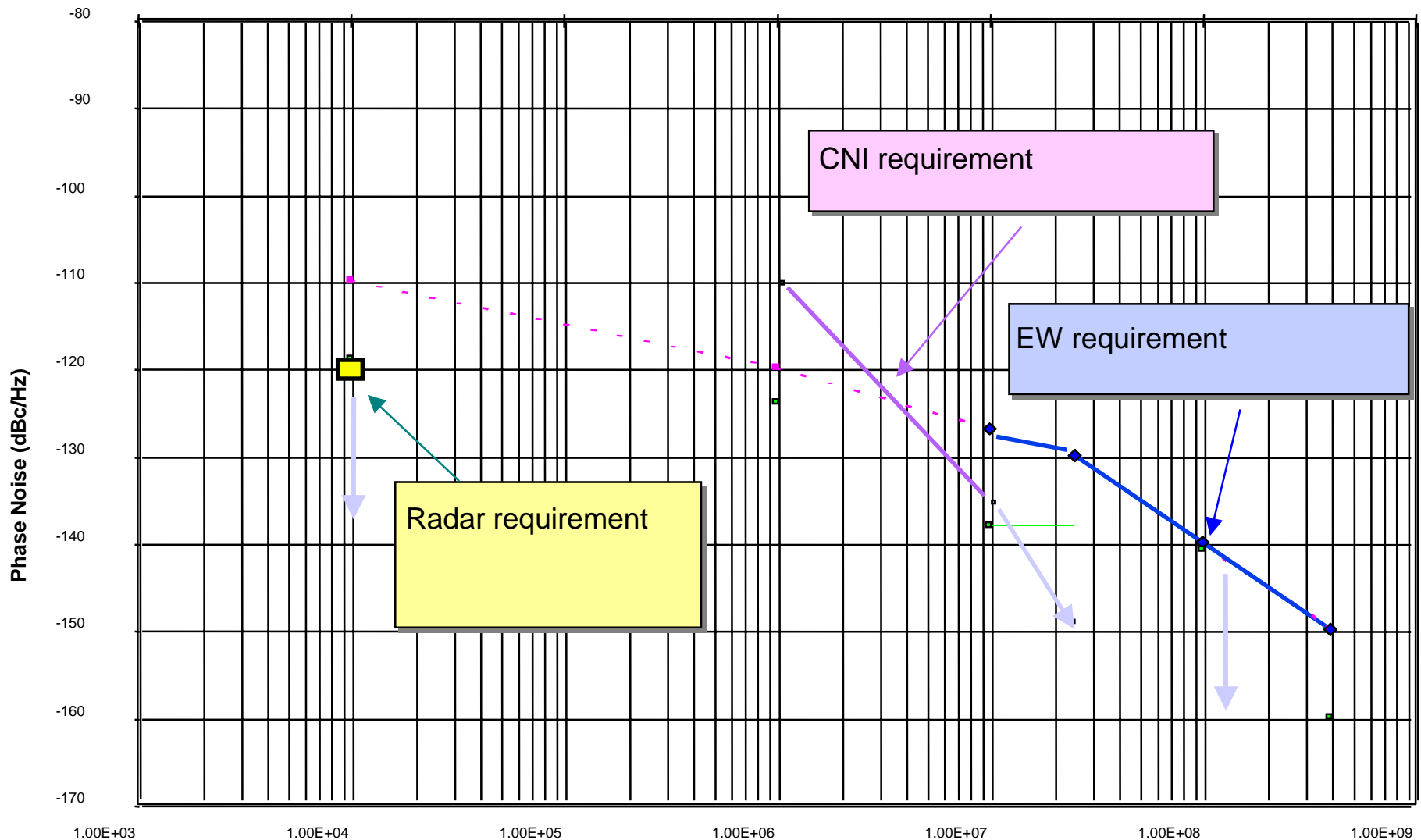
Performance Requirements for Current & Near-term Radar Systems

- Noise Figures from 3 – 10 dB
- SFDR better than 80 – 120 dB/Hz^{2/3}
- Relative Noise at 10 KHz from RF carrier < 80 – 130 dBc/Hz
- Frequency Range to cover sub-GHz – 100 GHz with up to 50% BW
- Amplitude stability better than ± 0.3 to ± 1.5 dB
- Frequency accuracy better than ± 1 MHz
- Switching times of $1\mu\text{sec}$ to $100\mu\text{secs}$ (beam steering)
- Filter bandwidths from 1 MHz to several GHz
- Delays from tens of nanoseconds (beam steering) to tens of mSec (signal processing)
- Delay precision from 1-10 picoseconds
- Out of band filter rejection from 30 to 50 dB (optical) at 0.5% of bandwidth



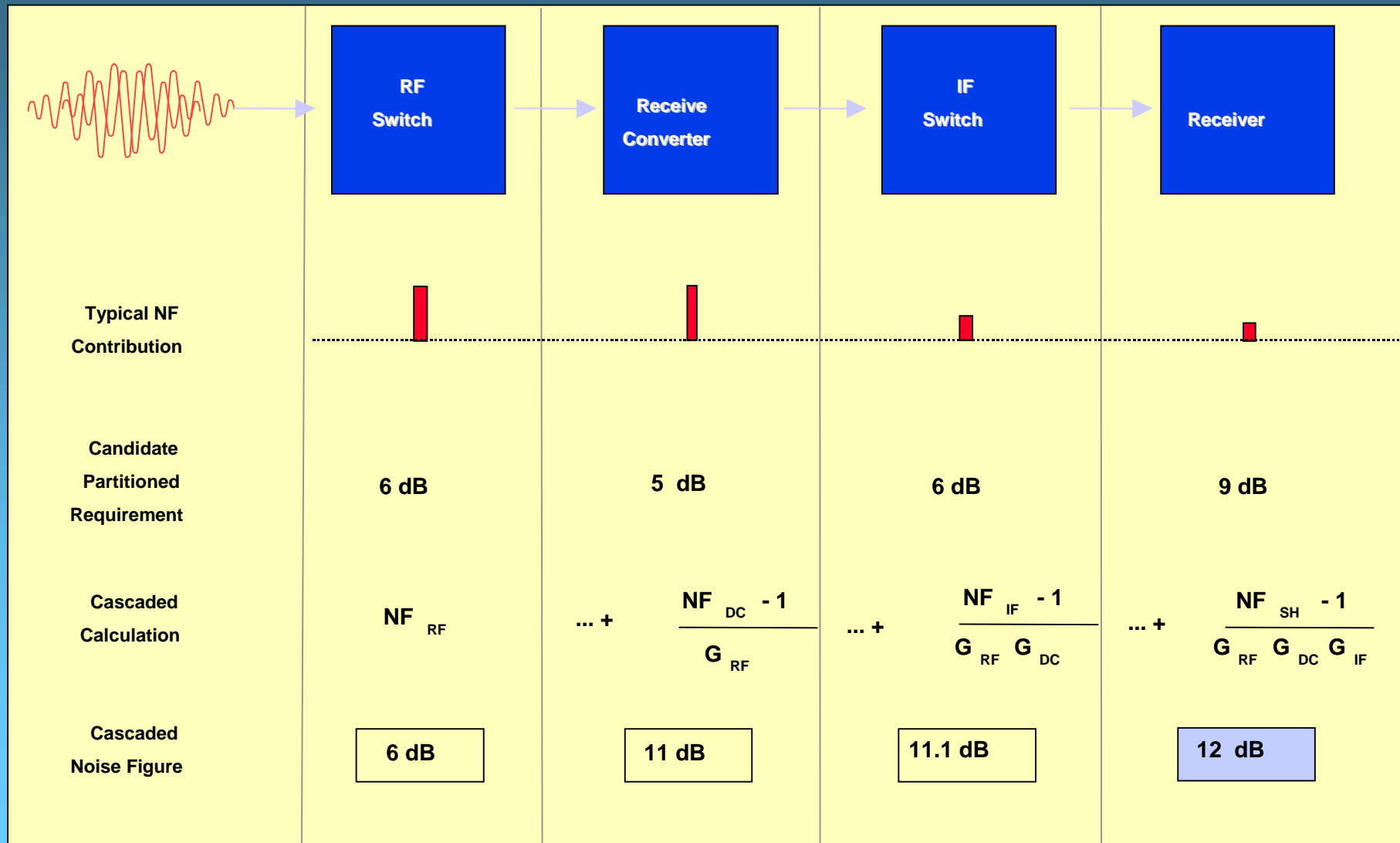
PHASE NOISE REQUIREMENTS

LO Phase Noise Requirements for ISS



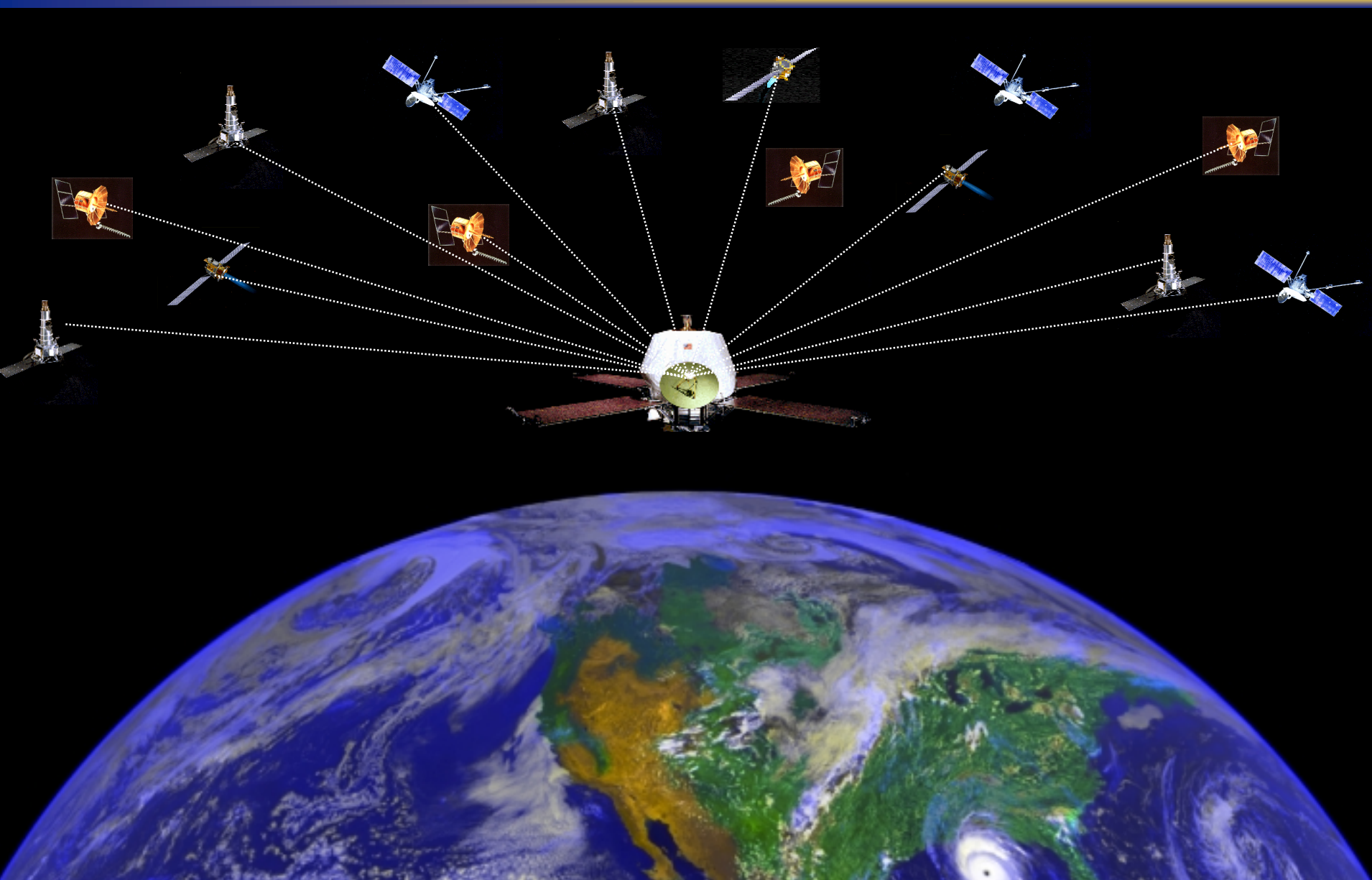


MODULES WITHIN RADAR THREAD



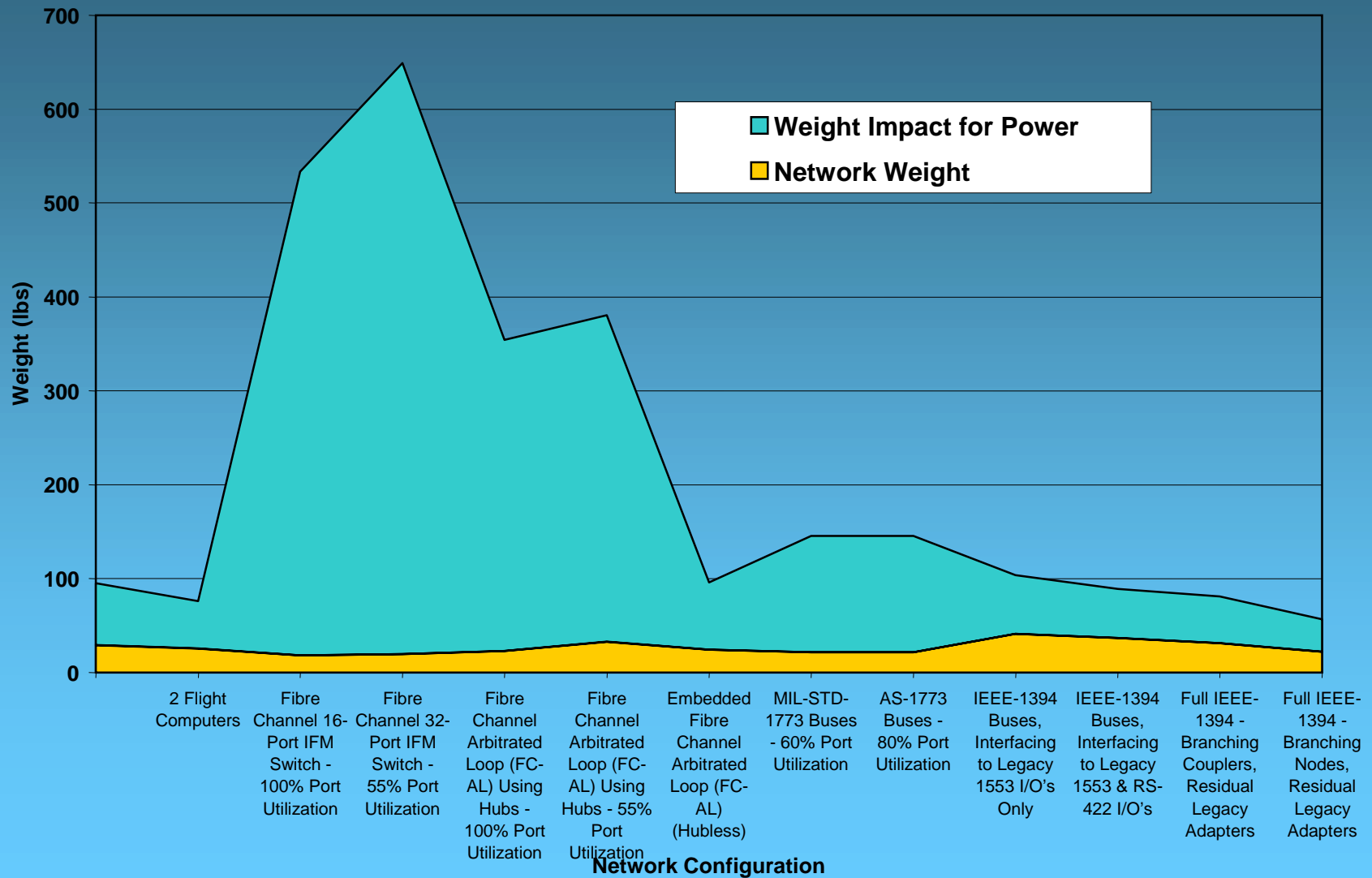


Future Space Systems



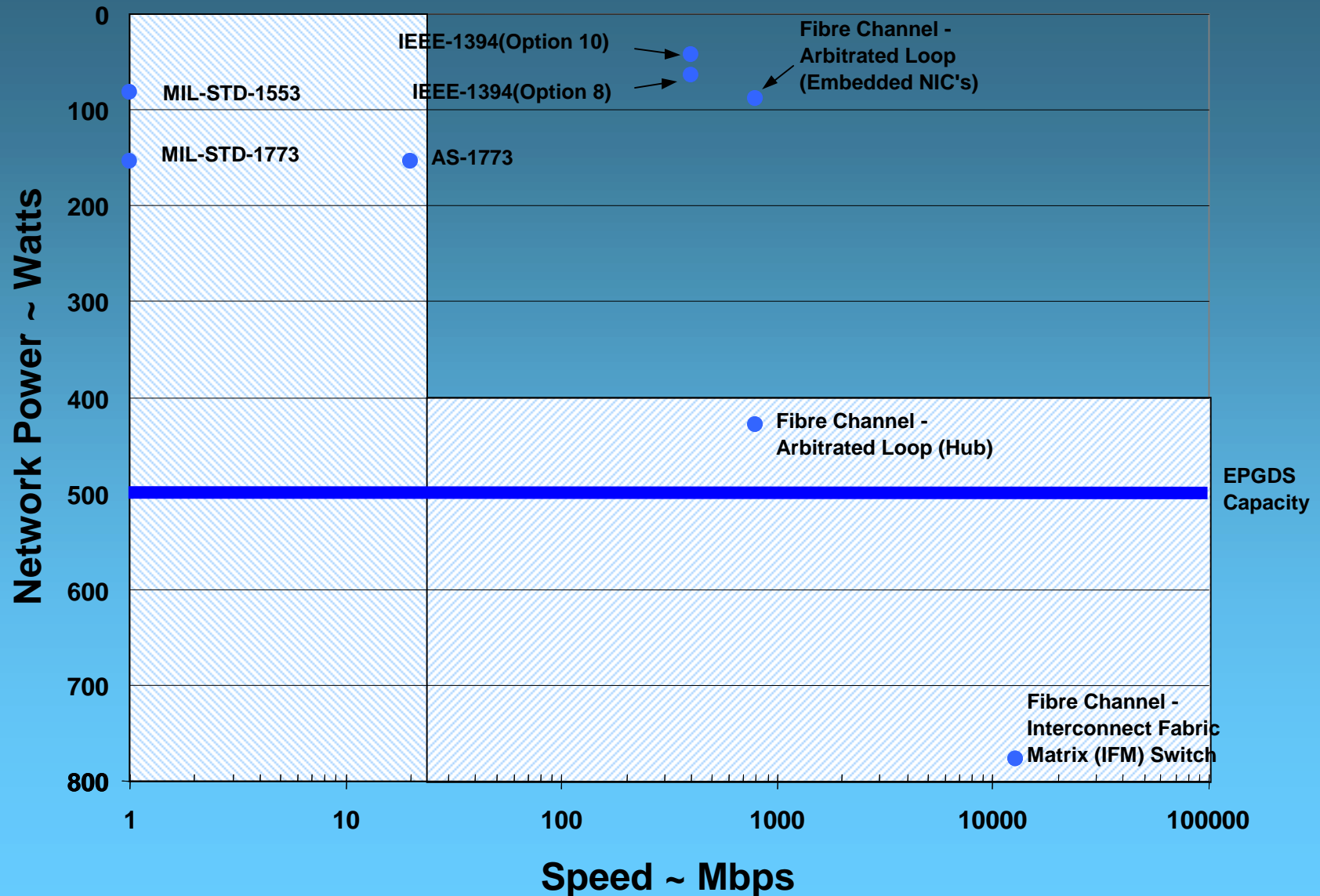


Network Options -vs- Weight Impact for Space Platforms





Bus Speed/Power Comparisons





Needed Developments

- **Tunable Laser Arrays**
 - Low-cost, High-Power, Narrow-Linewidth
 - Interface Issues (Insertion Loss)
 - Temperature stability issues
 - Bandwidth, Dynamic Range, Isolation between channels
- **Mix-Mode Capability**
- **Photo-Receiver Arrays**
 - High-Power Capability
- **Optical tunable filters**
- **Low-noise Amplifiers**
- **Packaging Issues**

